SECURE COMPARTMENTED INFORMATION WITH SMART RADIO SYSTEMS (SCISRS)
UNIVERSITY OF OKLAHOMA CAPABILITIES STATEMENT

The University of Oklahoma
Advanced Radar Research Center (ARRC)
http://arrc.ou.edu

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ARRC Overview & Relevant Capabilities

The University of Oklahoma's Advanced Radar Research Center (ARRC) is a premier academic research center specializing in radio-frequency (RF) hardware, systems, applications, and processing. The ARRC's strengths include RF system architectures, tunable electronics, embedded software for RF systems (including using GNU Radio to program software-defined radios, or SDRs), rapid prototyping, waveform design, beamforming and DSP, and novel signal processing for RF applications. The ARRC currently comprises 20 faculty and research scientists, 70+ students, 15+ full-time technical staff, post-docs, and administrative staff. Faculty researchers come from several different academic home departments, thereby creating a vibrant mix of expertise across applications and technology areas. As an academic research center, the ARRC provides the structure and resources to bring disparate skills together for enhanced collaboration on the toughest problems in RF and applied electromagnetics.

As shown below in Figure 1, the ARRC supports research across the full cycle of innovation. From theoretical work and conceptual studies to full-system, fielded prototypes, the ARRC has demonstrated R&D expertise at every level. Of particular relevance to SCISRS, the ARRC has expertise in RF signal and system simulation, theoretical development and analysis of processing algorithms, various SDRs for use in testing and prototyping of algorithms and software, application of machine learning techniques to RF systems, and fully-adaptive /cognitive RF systems. For SCISRS, The ARRC can support algorithm development, high-fidelity simulation of propagation environments and system behavior, implementation and testing of proposed algorithms via SDR embedded software & FPGA programming, affordable data collection and experiments using several SDR platforms (often with reduced red tape/administrative burdens), prototyping of digital backend solutions, and other critical technologies.

With plentiful testbeds, test equipment, world-class facilities, and a broad and committed group of faculty and staff researchers, the ARRC has truly unique capabilities to provide value-added R&D support to prime performers on the SCISRS program, particularly related to high-risk, high-reward algorithm development and experiments/testing/software development on a variety of SDR platforms.

Facilities

The Radar Innovations Laboratory (see Figure 2 and https://arrc.ou.edu/ril.html) is a university building and research facility operated by the ARRC. The 35,000-sqft RIL is a multidisciplinary research facility supporting students, faculty, and research across a wide range of disciplines with ties to applied electromagnetics and RF systems and applications. The RIL includes: two precision anechoic chambers; a very large 20' x 20' near-field scanner available in 2021; a small near-field antenna test system capable of planar, cylindrical, and spherical operating modes; lithography, precision milling (drill and laser), 3D printing (including multi-material, conformal printing), electro-plating, multilayer lamination, and other fabrication

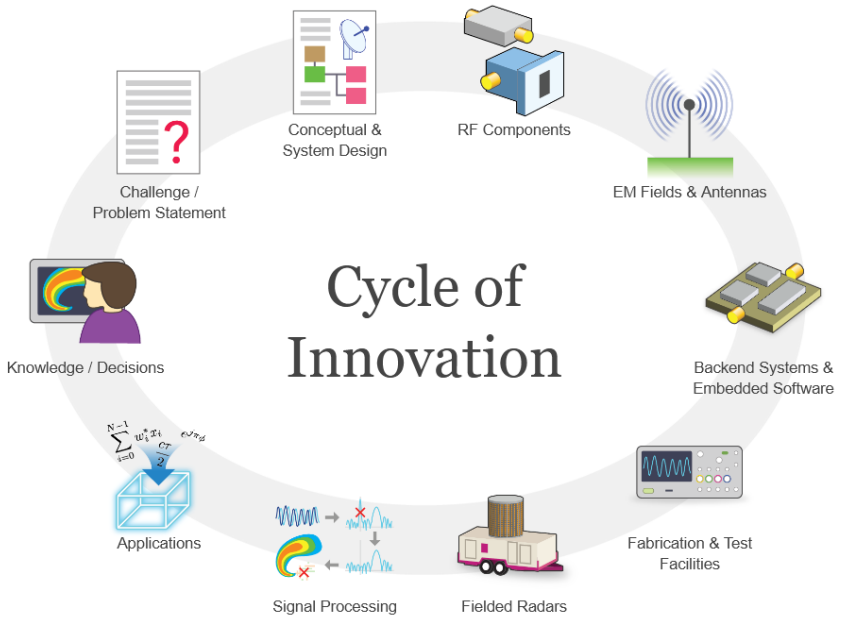

Figure 1. The ARRC performs R&D at all levels of innovation, from theoretical and fundamental research to prototype development and field testing.

Figure 2. Photograph of the ARRC's Radar Innovations Laboratory (RIL).

capabilities; high-bay garage for mobile radar development; rooftop experimental deck; and a secure room for supporting ITAR-controlled data and hardware development. The ARRC owns a wide range of electronic test equipment, including network analyzers with multi-port upgrades, spectrum analyzers with phase noise and noise figure capabilities, a real-time spectrum analyzer, software-defined radios (including multiple articles each of HackRFOne, BladeRF, Ettus B210, and Ettus X310 radios), arbitrary waveform generators, and a myriad of analog andvector signal generators, high-speed oscilloscopes, software packages (such as HFSS, FDTD, Altium, Vivado, etc.), and other equipment (see Figure 3).

The RIL is a restricted-access facility with designated areas for export-controlled research. The University of Oklahoma also possess a Facility Clearance at the Secret Level.

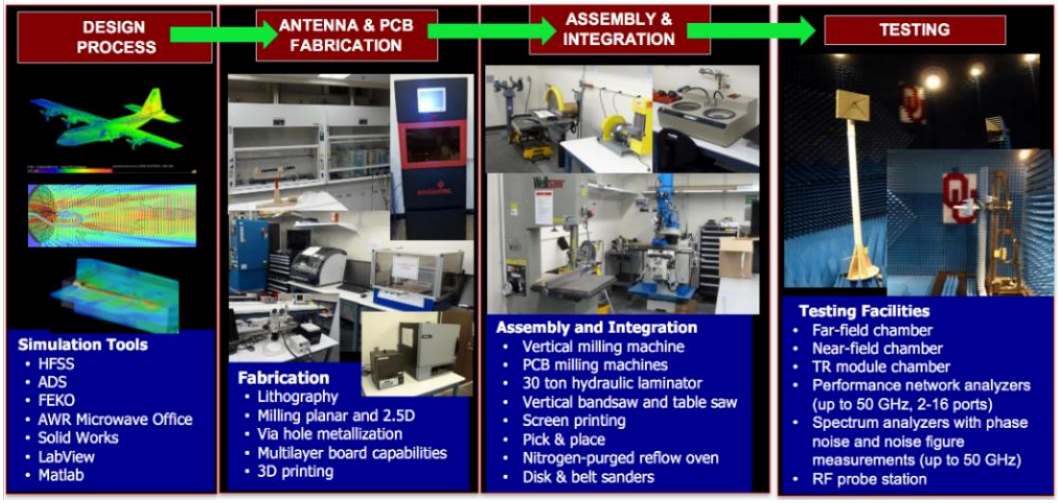

Figure 3. Prototyping capabilities at the ARRC's RIL.

Selected Personnel

The ARRC currently comprises 20 principal investigators (faculty, research scientists, and adjunct members), 15+ full-time technical staff, approximately 70 graduate students, post-doctoral researchers, and administrative staff. In the following, we provide brief descriptions of two faculty members with closest relevance to the vision of SCISRS as well as our full-time engineering staff. Many others have relevant backgrounds, which can be found on the ARRC's website (https://arrc.ou.edu/people.html).

Dr. Nathan Goodman has worked on signal processing techniques for radars and other sensors for over 25 years. He has strengths in adaptive measurement optimization, adaptive filtering, signal detection, RF signal modeling, distributed beamforming, compressive sensing, and statistical signal processing. Dr. Goodman's research in cognitive sensing has focused on real-time optimization of sensing parameters to maximize information extraction for the sensing task at hand. This framework has been applied to waveform design, multistatic sensor cooperation, phased array beamsteering, compressed sensing kernel optimization, and other tunable sensing parameters and systems. Dr. Goodman has experimentally demonstrated custom compressive receiver designs and algorithms, as well as application of sparse signal reconstruction to RF sensor data. He is currently investigating the application of machine learning techniques to cognitive sensor parameter selection and resource scheduling. Professor Goodman is the Conferences Committee Chair for the IEEE AESS Radar Systems Panel, was a General Co-Chair for the 2018 IEEE Radar Conference held in Oklahoma City, and has served as a NATO lecturer and Research Task Group Co-Chair. He currently serves as the ARRC's Director of Research.

Dr. Justin Metcalf has contributed to a wide range of research problems, including low-probability-of-intercept communications, applying machine learning to cognitive radar detection, multi-function waveform design, game theoretic decision support, space-time adaptive processing, and space-based radar. His research has an emphasis on cross-disciplinary

problems relating defense-oriented radar and communications applications with cognitive RF resource management and spectrum sharing. He is currently developing GNU Radio cognitive radar systems designed to operate in shared spectrum with dynamic communications interference. He has been investigating physical layer characteristics of radar and communications signals to inform spectral co-existence metrics and requirements. This research is highly applicable to the detection of anomalous signals using hardware agnostic software defined systems. He is a Senior Member of the IEEE and was the winner of the 2017 IEEE Dayton Section Young Professionals Award and the Richard K. Moore Best Master's Thesis Award at the University of Kansas. He is the recipient of a 2020 DARPA YFA and maintains an active security clearance. Before joining the faculty at OU, Dr. Metcalf worked several years for the Air Force Research Laboratory's Sensor Directorate.

Engineering Technical Staff: The OU ARRC maintains a team of full-time technical staff who support the center's research in a variety of ways. The engineering team enables the ARRC to respond to rapid-response requests while also maintaining the institutional knowledge needed for large-scale, multi-year projects and for maintaining the deployment of experimental systems. This permanent, full-time technical staff currently stands at 15 team members.